Developing an instructional material using a concept cartoon adapted to the 5E model: A sample of teaching erosion

Salih BIRISÇI[#] and Mustafa METIN

Artvin Coruh University, Faculty of Education
Department of Primary Education
08000, Artvin, TURKEY

Email: birisci@gmail.com and mustafametinae@hotmail.com

[#]Correspondence author

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Abstract

Using different instructional materials adapted within the constructivist learning theory will enhance students' conceptual understanding. From this point of view, an instructional instrument using a concept cartoon adapted with 5E model has developed and introduced in this study. The study has some deficiencies in

investigating students' conceptual understanding about the topic, but further research should be undertaken in order to investigate its effectiveness in a comparative manner.

Keywords: Constructivist Learning, Learning Materials, 5E Model, Concept Cartoon, Environmental Problem, Erosion.

Introduction

Concepts are the basic parts of knowledge, and they help human beings to organize and categorize the learning outcomes. In order to learn a concept, students should adapt their knowledge, attitude and skills previously acquired with new learning (Yürük, Çakir & Geban, 2000). In this instance, students' pre-existing knowledge may be characterized as misconceptions when they will be conflict with the scientific realities (Yilmaz, 1998; Ürey & Çalik, 2008). Determination of students' prior knowledge and misconceptions about a subject is a very important issue in acknowledging students. Additionally, scientific realities in books and the formation of their negative results can be so complex for students (Francis, 1993). For this reason, it is an important issue to consider which appropriating methods for teachers to use in their lessons. There are many kinds of approaches, one being the constructivist approach.

The constructivist approach points a shifting paradigm towards learner-centered or learner-focused instruction. In this approach, the teaching and learning paradigm has shifted from traditional classrooms where a teacher is at the center of the classroom. Constructivist epistemology assumes that students learn from their interactions with their environment. According to constructivist theory, learning is an active process that individuals construct meaning and interpret situations from their previous knowledge and experiences (Driver & Bell, 1986). Constructivism draws on the developmental work of Piaget (1977) and Kelly (1991). Twomey (1989) defines constructivism as a reference to four principles: learning depends on what we already know; new ideas occur as we adapt and change our old ideas; learning involves inventing ideas, rather than mechanically accumulating facts; meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas that are in conflict with our old ideas. In the constructivist class environment, the teacher's role is to provide students activities actively involving and facilitating this process (Gray, 2007).

In a constructivist learning environment, the teachers play the role of a guide and helps students to connect their prior knowledge with new information. Students play an active role by actively involving themselves in the learning process and constructing their knowledge by taking a part in activities (Kroasbergen & Van Luit, 2005). Instructional materials that are developed for learning and teaching a lesson also have an important role in creating a constructivist classroom environment. In this stage, most teachers have a problem with the restriction of utilizing perceptible instructional materials in a classroom environment (Metin & Özmen, 2009). Thus, it is important for students to be actively involved in the learning process. Proper learning materials must be prepared and used for meaningful learning outcomes (Özalp, 2006; Ugurel & Morali, 2006; Balim, Inel, & Evrekli, 2008). One of these learning materials is the concept cartoon.

Concept cartoons are a new approach to teaching, learning and assessing in science, created by Keogh and Naylor (1999). They feature cartoon-style drawings, showing different characters arguing about an everyday situation and are designed to intrigue, provoke discussion and stimulate scientific thinking, and may not have a single so-called right answer (Keogh & Naylor, 1999). A typical concept cartoon has the following features: visual representation of scientific ideas; minimal text in dialogue form; alternative viewpoints on the situation; scientific ideas are applied in everyday situations; the scientifically acceptable viewpoint is included in the alternatives; and the alternatives are given equal status (Keogh & Naylor, 1999). Concept cartoons can be prepared as posters or worksheets that can be distributed to students in a classroom (Kabapinar, 2005).

Concept cartoons, which have the aforementioned features, can be used in different ways in educational settings. They are seen as tools that allow teachers to gain students' attention, visually focus them on the lesson and create an environment where students can construct or reconstruct their views on a certain topic (Balim, Inel, & Evrekli, 2008). These cartoons can be used at the beginning of a lesson to examine students' prior knowledge, reveal their thoughts and force them to discuss a certain concept (Keogh et al., 2001; Keogh, Naylor, & Downing, 2003; Kabapinar, 2005; Duralp, 2006; Balim, Inel, & Evrekli, 2008).

Utilizing concept cartoons in the classroom can reveal misconceptions and uncertainties on different kinds of subjects by helping students question their ideas, improve their thinking ability, look at events from different angles and connect and

widen different concept activities (Dabell, 2004). One of these subjects with misconceptions is environmental problems (weather, water pollution etc.). Among these problems, the most misconceptions are in the subject of erosion (Pinar, Dikmenli & Buldur, 2000; Bozkurt, Akin & Usak, 2004; Gaither, 2008). Misconceptions are that:

- Students don't fully know the description of erosion;
- Students confused the description of erosion with concepts such as landslide, earthquake;
- Students have incomplete and wrong knowledge about factors that effect erosion; and
- Students have incomplete knowledge about the correlation between structure of soil and erosion.

In order to cope with environmental problems, a great importance must be given to education. In the course of lessons, gaining sensitivity and concerning on erosion students' attention must be attracted to lessons by taking advantage of different kinds of instructional materials up to different problem types. For further researches, investigating students' prior knowledge and misconceptions or correcting and improving uncertainties about erosion in the same way, an instructional instrument was developed and introduced in this study.

Methodology

In this study, an instructional material was designed intended for "Earth's Crust Composed of What?" unit in six grade science and technology curriculum in Turkey. Inside of this unit "Soil Erosion" subject has been taken. Students at this stage have studied science lessons related with environment and environmental issues since fourth grade in prior years.

In this instrument we illustrated the instructional material as concept cartoons in computer environment. However, as an alternative, it is also possible to design concept cartoons via multimedia software. In this study cartoons were designed in MS PowerPoint software.

The content of computer supported concept cartoons are similar to regular ones and include a topic with different characters. Characters within cartoons might move or be still pictures, and they can include a musical background. Concept cartoons are

designed for a computer-equipped environment so that the cartoons can be projected on a wall or blackboard and all students can see them. When the cartoons are first projected, different characters appear, however, their thoughts on a certain subject are not presented, and students can only see the characters and the empty talking balloons over their heads. The teacher starts the lecture by asking students their thoughts on the topic appearing on the screen. In this way, without being able to see characters' thoughts on the topic, students' prior knowledge of the topic can be examined. Later students can see characters' thoughts on the topic by scrolling over and clicking with the mouse one by one where each character's thought appears on the talking balloons. One of the opinions on the talking balloons should be close to the right answer explaining the concept, and the others might be different misconceptions about the concept. After explaining the characters and their opinions, the teacher can ask students which characters' views they agree and why they agree with that view. Students start to explain with which character they agreed with and why. Students can see whether characters' thoughts on the topic are true or false by scrolling over and clicking with the mouse on the talking balloons and another window appears that explains why the opinion is true or false. In this way, the teacher can see where students hold misconceptions and create a class environment where student can freely express their opinions.

After preparing this instrument, it adapted to the constructivist 5E model. Bybee (1997) developed an instructional model for constructivism called the 5E Model. This model consists of activities that enhance students' interest towards investigation, meet their expectations and have active usage of knowledge and abilities (Özsevgeç, 2006). The 5E model consists of five steps: enter/engage, explore, explain, elaborate and evaluate (adapted from Bybee et al., 2006; Çepni et. al., 2005; Cardak, Dikmenli & Saritas, 2008; Ürey & Çalik, 2008):

Enter/Engage Phase: It helps students to identify what they have known about the subject in order to distinguish their old ideas. In this phase, the lesson is started by an entertaining and attractive presentation, and some questions about the reasons for the event are asked. Here, it isn't important to find the correct response, but to encourage students to put forward different ideas by questioning.

Explore Phase: Students produce new ideas to solve the problem by studying together, conducting experiments and studying using computers, videos or in a library environment. These ideas are turned into abilities and solutions to solve the

problem after filtering by the teacher. This is a phase where students are most active.

Explain Phase: In this phase, the teacher helps students to substitute new and correct ideas for old and inadequate ones. This is the most teacher-centered phase of the model. The teacher makes formal descriptions and scientific explanations.

Elaborate Phase: Students apply their newly gained information and problem solving approach into new events and problems. They learn new concepts that didn't exist in their minds before.

Evaluate Phase: This is the phase in which the teacher observes students while they are solving problems and asks them open-ended questions. This is also the phase where students evaluate their own development in learning new concepts and abilities. In this last phase, students form a conclusion by evaluating their new knowledge and abilities.

As a conclusion, we try to adapt each phase of the constructivist 5E model within the concept cartoons.

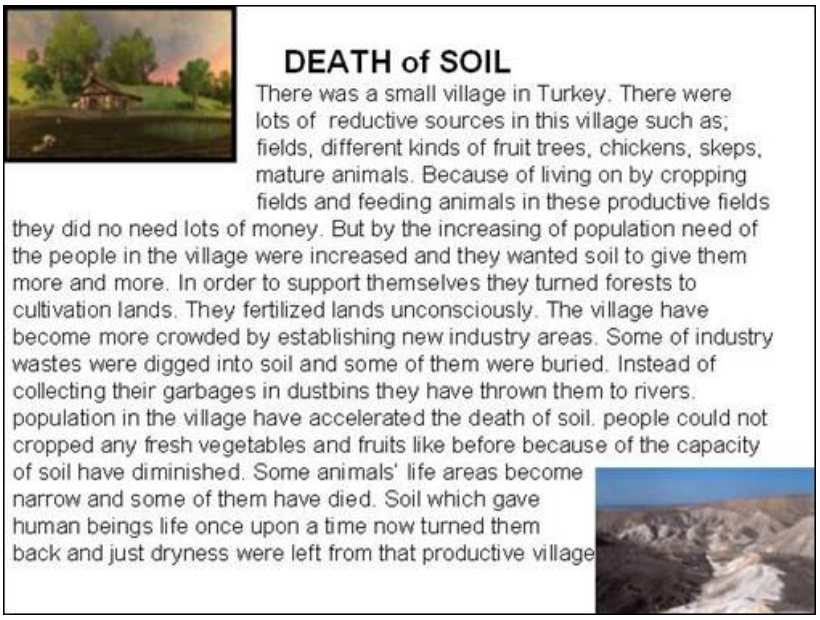
Instrument Design: Concept Cartoon Description Adapted with 5E Model

In this section we will illustrate the instrument phase by phase:

Enter/Engage

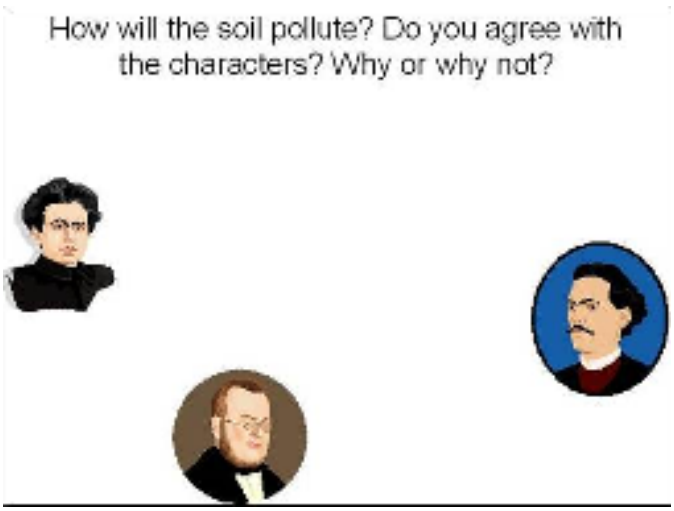
In this phase, the teacher identifies the students' prior knowledge and gets them to engage in a new concept by means of short activities or questions promoting curiosity and increasing their awareness of their pre-existing knowledge. Before handling out the instrument, students are divided into groups of 3-4 students. Firstly, an intriguing short story that is related to soil pollution was introduced to students (Figure 1).

Figure 1. *An intriguing story.*



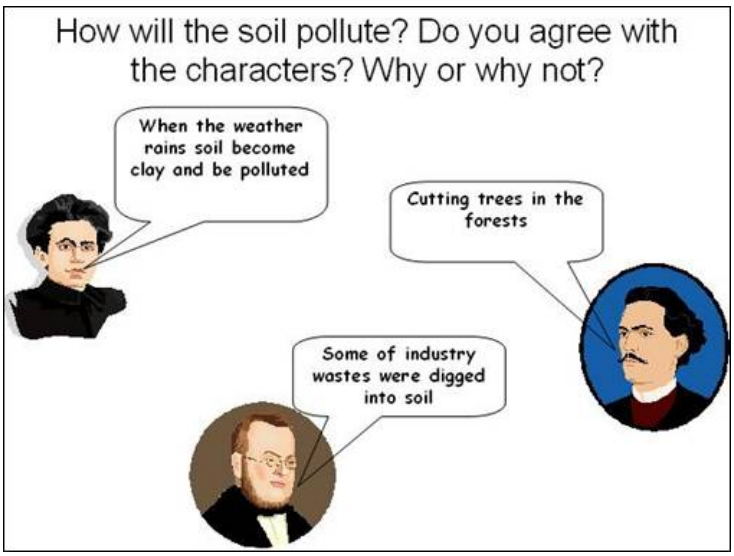
After reading the passage three questions related with this story wee "How will the soil pollute?"; "Which effects occurred when a soil polluted?"; and "What is the reason for the erosion?" were asked to the characters. For example the questions "How will the soil pollute? Do you agree with the characters? Why or why not?" were asked to the three characters (Figure 2).

Figure 2. *A question is asked to characters.*



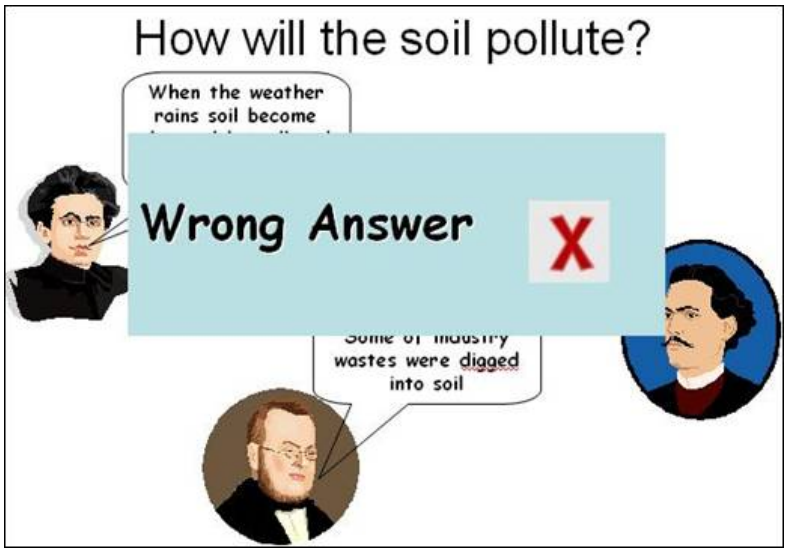
When clicking over each of the characters in the cartoon, they state their views about the question with dialogue boxes (balloons) over their heads, and each character states different views about the question (Figure 3).

Figure 3. *Characters state their views.*



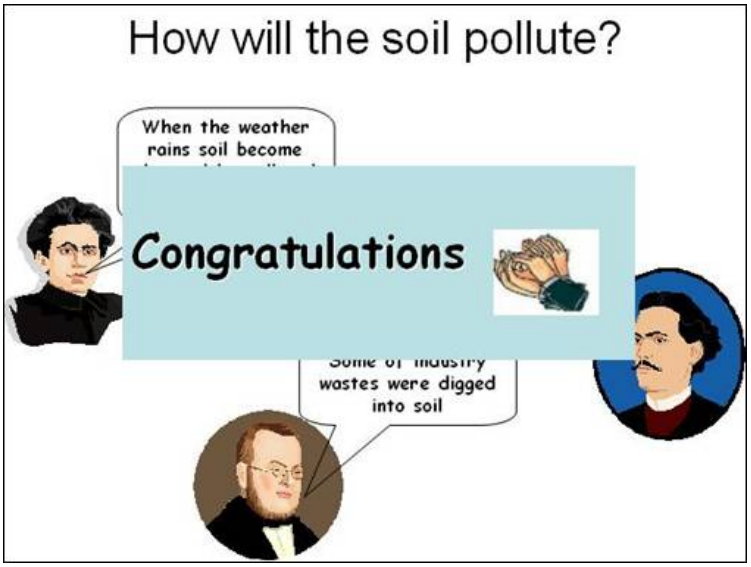
One of the views in these dialogue boxes is accepted as scientifically true and the rest are considered to be wrong. In this stage, students should click on one of the dialogue boxes appearing on cartoons heads if he/she thinks has the right answer. If a student clicks on the wrong answer, a wrong answer signal alerts the student and a written message is shown (Figure 4).

Figure 4. *The answer is considered as wrong.*



If a student clicks on the right answer, a right answer signal alerts the student and a written message is shown (Figure 5).

Figure 5. *The answer is considered as right.*



By doing this activity, students' attention was focused on the topic and they are personally involved in the lesson by asking other questions.

Explore

Assisting students is very important in this stage, rather than teaching directly. Teachers should encourage students to work in their groups and ask probing questions without any clues to redirect their investigations. In this way, students can acquire new knowledge by linking to prior knowledge. To meet this stage's requirements, characters help students in the groups by performing three experiments related to three kinds of erosion type as water, wind and waves. These types of experiment instructions are given (Figures 6, 7 and 8). In Figures 6, 7 and 8, characters performing experiments according to the instructions given to students and they guess which type of erosion is shown. In the entrance phase, statements in these dialogue boxes are accepted as scientifically true, and the rest are considered to be wrong. While in this phase, teachers must perform these given instructions with the student groups in the classroom. In terms of the experiment results, both characters and students should guess which type of erosion is shown and which character supports the right one. As a result, this stage is very important in restructuring students' prior knowledge and thinking structures.

Figure 6. *Characters doing experiments.*

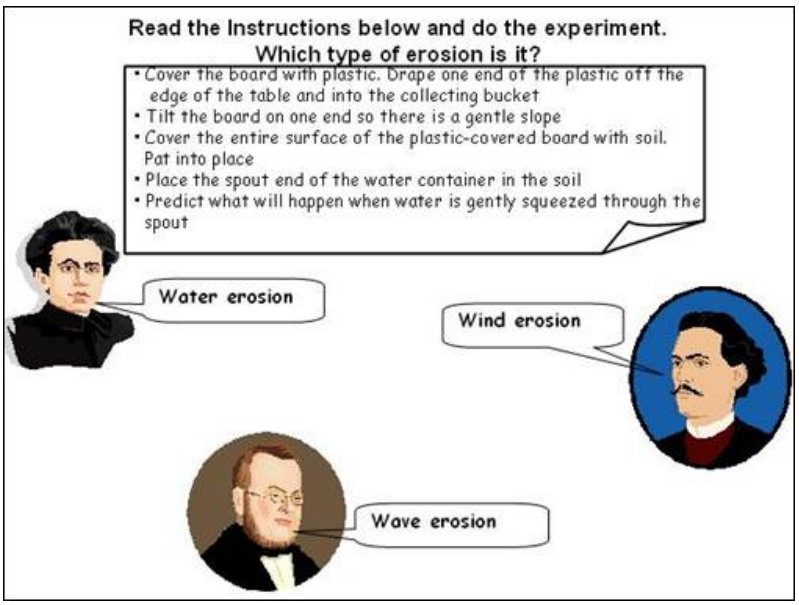


Figure 7. *Characters doing experiments.*

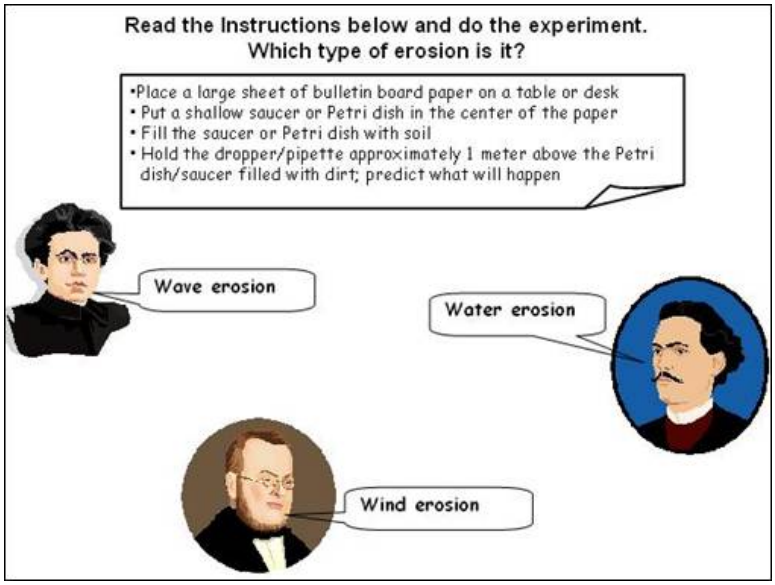
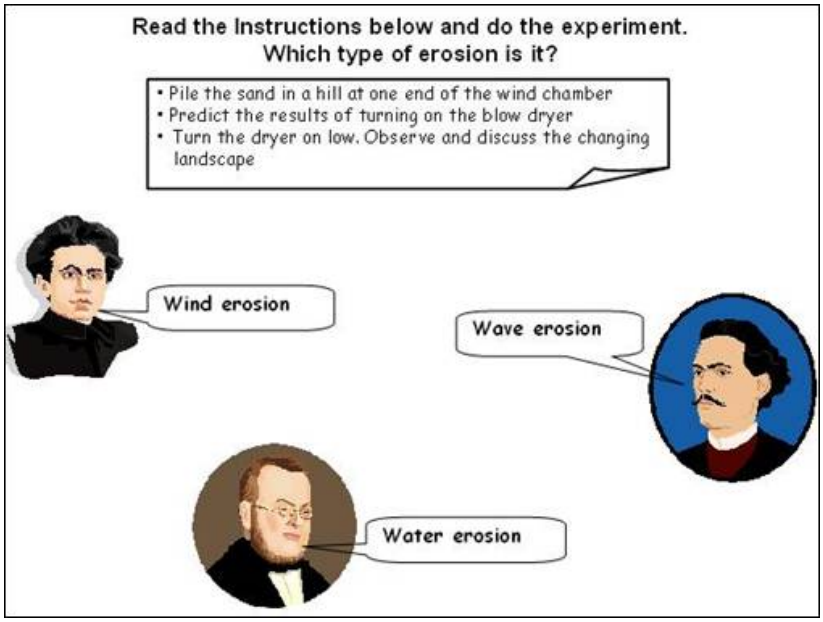


Figure 8. *Characters doing experiments.*

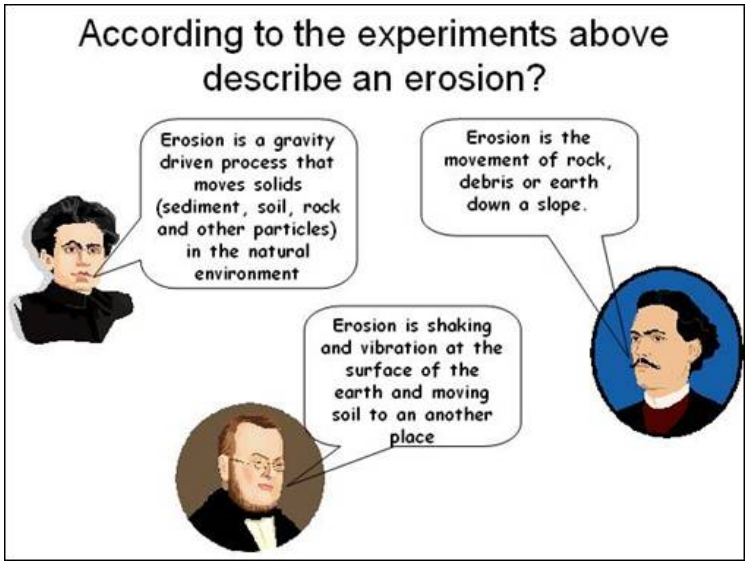


Explain

This phase provides an opportunity for teachers to directly introduce new concepts, processes or skills. Hence, teachers have a chance to confirm or disconfirm students' knowledge. Students have a chance to compare their newly structured ideas with those presented by the teacher. Knowledge that students have learned at

the exploration stage is very important for this phase. Group ideas were revealed about the results of each experiment after performing its instructions. Each group discusses their ideas, and finally they agree on each type of experiment. From this point, the instrument gives some connected questions with the exploration part to students. For example, "According the experiments above, describe erosion?" (Figure 9 in Appendix).

Figure 9. *Descriptive questions.*



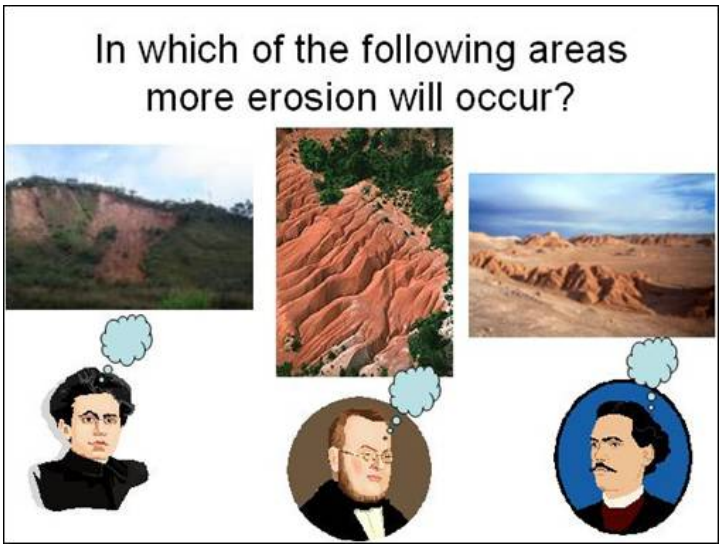
As in Figure 9, characters state their views on description of the erosion. One of the characters defends a correct description, others state misconceptions that are revealed in literature about erosion. By having students answer the questions and support one of the characters' ideas, teachers can reveal students' understandings about erosion. By doing this activity, teachers have a chance to correct misconceptions when a student states a wrong explanation or defends a wrong character.

Elaborate

In this phase, the teacher fosters students to apply their understandings and skills to additional activities, and thereby they attempt to extend their newly structured knowledge to a deeper and broader understanding, more information and adequate skills. For this purpose, the elaborate phase in this instrument shows characters

three different kinds of an erosion area and asked them, "In which of following areas more erosion will occur?" to deeper students' understanding (Figure 10).

Figure 10. *Extending knowledge to other situations.*

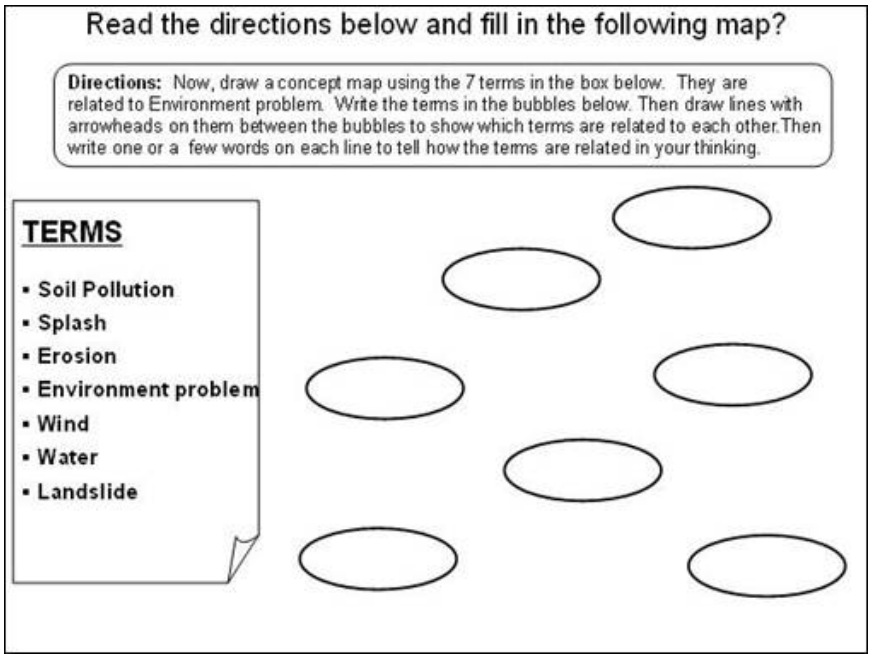


By using the characters' ideas, students should think about the shapes that will cause more erosion. In order to answer this question, students' pre and newly structured knowledge, which is gained from previous phases, are very important to reflect upon in other situations.

Evaluate

This phase not only promotes students to assess their understanding and abilities, but also gives an opportunity for teachers to monitor how students' understandings have progressed. In order to assess what students have learned and how much they have increased their knowledge about erosion in previous phases, an activity is introduced. This activity consists of a concept map that has many gaps related to each other and many words for placing these to gaps (Figure 11).

Figure 11. *An activity to assess students' learning outcomes.*



When each group completes the activity, they can compare their answers with the other groups. After discussing with the teacher on the correct form, they can realize their missing concepts. At the same time, students will reach a conclusion about the topic by assessing new knowledge and skills in this phase.

Further Research

An instructional learning instrument is introduced in this study to teach the concept of erosion. This study has some limitations. The instrument was designed for six grade elementary students on the subject of soil erosion. To determine how it affects conceptual understanding of the subject of erosion and to investigate its' effectiveness, further research should be undertaken in a comparative manner. After implementation, parts of this instrument may be changed and improved in terms of sample's needs and it can be adapted with different kinds of environmental problem areas. In this way, the instrument can cause gains in awareness and sensitivity towards environment for students.

References

Balım, A.G., İnel, D. & Evrekli, E. (2008). The effects the using of concept cartoons in science education on students' academic achievements and enquiry learning skill perceptions. *Elementary Education Online, 7*(1), 188-202.

Bozkurt, O., Akın, S.B. & Uşak, M. (2004). İlköğretim 6., 7. ve 8. sınıf öğrencilerinin "erozyon" hakkındaki ön bilgilerinin ve kavram yanılgılarının tespiti (Identifying of grade 6, 7. and 8. students' pre-informations and misconceptions about the erosion). *Gazi Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 5*(2), 277-285. [in Turkish].

Bybee, R.W., Taylor, A.J., Gardner, A., Scotter, P.V., Powell, J.C., Westbrook, A. & Landes, N. (2006). The BSCS 5E instructional model: Origins, effectiveness and applications. Retrieved from http://www.bscs.org/pdf/bscs5eexecsummary.pdf.

Bybee, R. W. (1997) *Achieving Scientific Literacy*. Portsmouth, NH: Heinemann.

Cardak, O., Dikmenli, M. & Saritas, O. (2008). Effect of 5E instructional model in student success in primary school 6th year circulatory system topic. *Asia-Pacific Forum on Science Learning and Teaching, 9*(2), Article 10.

Çepni, S., Ayas, A., Akdeniz, A.R., Özmen, H., Yiğit, N. & Ayvacı, H.Ş. (2005). *Kuramdan Uygulamaya Fen ve Teknoloji Öğretimi (Science and Technology Instruction from Theory to Practice)*. Ankara, PegemA Yayıncılık. [in Turkish].

Dabell, J. (2004). *The Maths Coordinator's File- Using Concept Cartoons.* London: PFP Publishing.

Driver, R. & Bell, B. (1986). Students' Thinking and the Learning of Science: A Constructivist View. *The School Science Review, 67*(240), 443-456.

Durualp, E. (2006). *The Caricatures That can be Usable in Teaching of Social Studies*, Unpublished Master's Thesis, Gazi University Education Sciences Institue, Ankara.

Francis, C., (1993). Ideas of elementary students about reducing the "greenhouse effect". *Science Education. 77*, 375-392.

Gaither, F.J., (2008). *Common misconceptions about weathering, erosion, volcanoes and earthquakes.* An Online Magazine for K-5 Teachers, Retrieved from http://beyondpenguins.nsdl.org/issue/column.php?date=December2008&departmentid=professional&columnid=professional!misconceptions.

Gray, A. (2007). *Constructivist Teaching and Learning.* Retrieved from http://saskschoolboards.ca/research/instruction/97-07.htm.

Kabapınar, F. (2005). Effectiveness of teaching via concept cartoons from the point of view of constructivist approach. *Educational Sciences: Theory & Practice. 5*(1). 135- 146.

Kelly, G.A. (1991). *The psychology of personal constructs* (Vols. 1 and 2). London: Routledge.

Keogh, B., & Naylor, S. (1999). Concept cartoons, teaching and learning in science: An evaluation. *International Journal of Science Education, 21*(4), 431-446.

Keogh, B., Naylor, S., De Boo, M. & Feasey, R. (2001). (Ed: B, Helgard) *Research in Science Education-Past, Present and Future, Formative Assessment Using Concept Cartoons: Initial Teacher Training in the UK.Hingham*, USA: Kluwer Academic Publishers.

Keogh, B., Naylor, S., & Downing, B. (2003). Children's Interactions in The Classroom: Argumentation in Primary Science. *4th European Science Education Research Association Conference*, Noordwijkerhout, Netherlands.

Kroasbergen, E. H. & Van Luit, J. E. (2005). Constructivist Mathematics Education for Students with Mental Reterdation. *European Journal of Special Needs Education, 20*(1). 107-116.

Metin, M. & Özmen H. (2009) Difficulties of pre-service teachers in developing and implementing teaching activities based on the 5E model in the constructivist approach. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 3*(2), 94-123.

Özalp, I. (2006). A Study on Implementıng the Technique of Caricature in Science and Environmental Education, Unpublished Master Thesis, *Graduate School of Natural and Applied Sciences*, University of Celal Bayar, Manisa.

Özsevgeç, T. (2006). İlköğretim 5. Sınıf Kuvvet Ve Hareket Ünitesine Yönelik 5E Modeline Göre Geliştirilen Rehber Materyallerin Etkililiklerinin Belirlenmesi. Yayımlanmamış Doktora Tezi, KTÜ, Fen Bilimleri Enstitüsü, Trabzon.

Pınar, A., Dikmenli, M. & Buldur, A. (2000). Erozyon kavramı üzerine öğrenci görüşleri (Student ideas on the concept of erosion). *S.Ü. Eğitim Fakültesi Sosyal Bilimler Dergisi, 9*, 1-9. [in Turkish].

Piaget, J. (1977). *The Development of Thought: Equilibration of Cognitive Structures*. (A. Rosin, Trans). New York: The Viking Press.

Sahan, G. & Yılmaz, O. (2007). İlköğretim Okulları 4 ve 5. Sınıf Yabancı Dil Öğretiminde Yeni Öğretim Teknikleri (Etkinlik Örnekleri), *İlköğretim Kongresi*, Hacettepe Üniversitesi, Türkiye.

Twomey, F.C. (1989). *Enquiring Teachers, Enquiring Learners: A Constructivist Approach for Teaching*. New York: Teachers College Press.

Uğurel, I. & Moralı, S. (2006). Karikatürler ve matematik öğretiminde kullanımı. *Milli Eğitim Dergisi*, 170. [in Turkish].

Ürey, M. & Çalık, M. (2008). Combining different conceptual change methods within 5E model: A sample teaching design of 'cell' concept and its organelles. *Asia-Pacific Forum on Science Learning and Teaching, 9*(2), Article 12.